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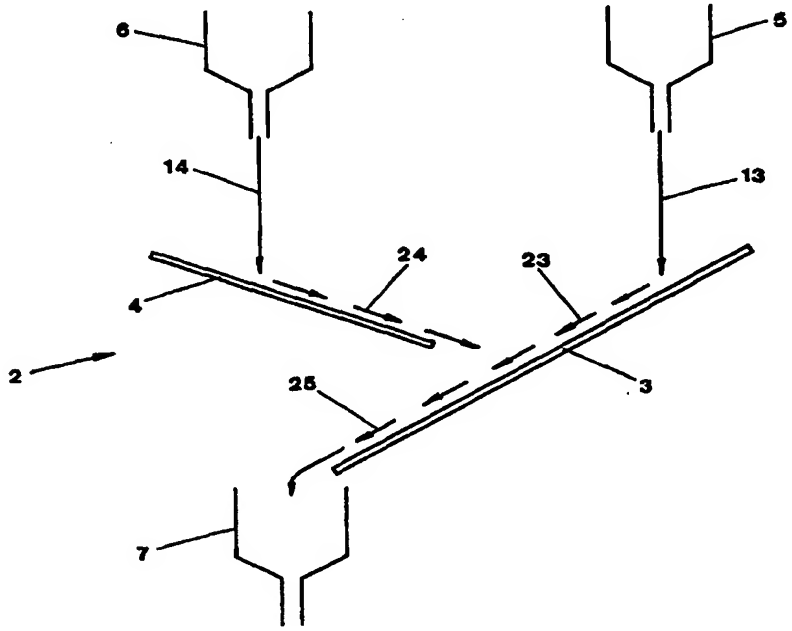
(54) Title: METHOD AND APPARATUS FOR MIXING GRANULAR OR POWDERED MATERIALS



(57) Abstract

A method of mixing granular or powdered materials comprises causing a stream of a first granular or powdered material to flow over an inclined surface (3) as a thin dispersed layer (23) flowing down said surface (3), and causing a stream of a second granular or powdered material to flow over an inclined surface (4) as a similar flowing thin dispersed layer (24). The layer flows of the materials intersect and intimately mix.

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METHOD AND APPARATUS FOR MIXING GRANULAR OR POWDERED MATERIALS

FIELD OF INVENTION

The invention comprises a method and apparatus for mixing granular or powdered materials.

BACKGROUND OF INVENTION

Many current methods and apparatus for mixing two or more granular or powdered materials normally involve batch mixing which interrupts the flow of the materials in a process. Forms of in-line mixers are known but can be prone to blocking.

SUMMARY OF INVENTION

The invention provides an improved or at least alternative method and apparatus for mixing granular or powdered materials.

In broad terms the invention comprises a method of mixing granular or powdered materials, comprising causing a stream of a first granular or powdered material to flow over an inclined surface as a thin dispersed layer flowing down said surface, causing a stream of a second granular or powdered material to flow over an inclined surface as a similar flowing thin dispersed layer flowing down said surface, and causing said layer flow of said second material to intersect with said layer flow of said first material to intimately mix said materials.

The invention also comprises apparatus for mixing granular or powdered materials, comprising a first inclined surface, means to direct a first granular or powdered material onto the first surface to spread to a thin dispersed layer flowing down the surface, a second surface inclined to the horizontal and towards said first surface, and means to direct a second granular or powdered material onto the second surface to spread to a similar flowing thin dispersed layer, whereby said layer flow of said first material spills from an edge of said second surface to intersect and intimately mix with said first material.

The invention also comprises apparatus for mixing granular or powdered material, comprising an inclined surface, means to direct a first granular or powdered material onto the surface to spread to a thin dispersed layer flowing down the surface, means to direct a second granular or powdered material onto the surface to

spread to a thin dispersed layer flowing down the surface whereby said materials intimately mix on the surface.

BRIEF DESCRIPTION OF THE DRAWINGS

The method and apparatus of the invention are described further with reference to the accompanying drawings, by way of example and without intending to be limiting, wherein:

Figure 1 schematically shows mixing apparatus of the invention utilising two inclined surfaces, from one side;

Figure 2 schematically shows the flow on one surface from above;

Figure 3 schematically shows another mixing apparatus of the invention utilising two inclined surfaces;

Figure 4 schematically shows mixing apparatus of the invention utilising a single inclined surface,

Figure 5 illustrates the use of flow guides to direct the material flow, and

Figure 6 shows a further form of mixing apparatus utilising two inclined surfaces.

DETAILED DESCRIPTION

Referring to Figures 1 and 2, mixing apparatus 2 comprises a first inclined flow surface 3, a first hopper 5, a second inclined flow surface 4, a second hopper 6, and a collection hopper 7.

The first hopper 5 is located above the flow surface 3 and directs a granular material stream or bulk flow 13 onto the upper region of the flow surface 3. Similarly the second hopper 6 is located above the flow surface 4 and directs a bulk flow 14 of a second granular material onto the upper region of the flow surface 4.

The surfaces 3 and 4 are inclined from the horizontal such that the bulk flows of granular material 13 and 14 respectively impact on the upper region of each of the two surfaces 3 and 4 and spread out as they flow down the surfaces 3 and 4 under gravity to thin dispersed layers 23 and 24 respectively. Figure 2 shows from above the bulk flow 14 from the second hopper 6 impacting on the surface 4, the bulk flow

14 spreading out substantially parabolically and flowing down the surface as a thin dispersed layer 24 of material.

The second flow surface 4 is arranged to direct the flowing layer of granular material 24 to intersect the flowing layer of granular material 23 on the flow surface 3. This interaction of the two material layers 23 and 24 intimately mixes the materials which then flow down the remainder of the surface 3 as a mixed flow 25 of granular materials. The mixed flow 25 then flows into the collection hopper 7.

In use, a bulk flow 13 of one granular material is directed from the first hopper 5 onto the surface 3. A bulk flow 14 of a second granular material is directed from the second hopper 6 onto the surface 4. Each bulk flow 13 and 14 impacts onto a surface 3 or 4 respectively, spreading out and flowing down the surface 3 or 4 as a thin dispersed layer 23 and 24 of granular materials. The second material flowing down the surface 4 is directed into the material flowing down the surface 3, mixing the two flows which then flow further down the surface 3 into the collection hopper 7. The flow of materials 13, 14 and 25 is uninterrupted by the mixing process.

Figure 3 shows a variation in which the two granular material flows 23 and 24 each spill from respective edges and intersect and mix in "mid air" immediately above the collection hopper 7.

Figure 4 shows mixing apparatus of the invention comprising a single surface inclined from the horizontal, a first hopper 5, a second hopper 6, and a collection hopper 7.

The first hopper 5 is located above the flow surface and is arranged to direct a bulk flow 13 of granular material onto the upper region of the surface. The granular material impacts on the surface, spreads out and flows down the surface under gravity as a thin dispersed layer 23 of granular material. The second hopper 6 is also located above the surface and is arranged to direct a bulk flow 14 of a second granular material onto the mid-region of the surface. The second granular material bulk flow 14 impacts on the surface, spreads out and mixes with the first thin dispersed layer 23. The resulting mixed flow 25 then flows into the collection hopper 7.

Figure 5 illustrates the use of flow guides to direct the material flow. In particular, flow guides may be utilised to reduce any thickening of the flow which may occur at the edges of the flow. Flow guides positioned as at 30 immediately above the point of impact of the stream of material flow onto the inclined surface and each to one

side of the point of impact have been found to assist in achieving a uniform thickness of flow down the inclined surface. Guides so positioned tend to redirect the material pushed upwardly from the point of impact, which naturally tends to flow towards the outer edges of the flow, down the inclined surface to spread more centrally into the material flow. Guides positioned as at 33 at the sides of the flow may also be utilised to direct any thickening of material at the sides of the flow towards the centre of the flow, to again assist in achieving layer flow down the surface which is as uniform in thickness as possible. Flow guides may be provided at other points in relation to the flow in addition to or alternative to those shown in Figure 5.

Optionally side barriers 35 may be provided at the sides of each flow surface, as indicated at 35 in Figure 5, so that the layer flow down the surfaces is of a constant and similar width. Flow guides such as those at 33 or otherwise suitably positioned at the sides of the flow may also be used to control the width of the flow. The width of the layer flow down the two (or more) inclined surfaces is preferably the same to promote homogeneous mixing of the two (or more) materials.

Figure 6 shows a form of apparatus of the invention which is similar to that of Figure 1 except that on each side the bulk material flows from outlets 40 positioned immediately above each flow surface, of hoppers 41. Optionally the hoppers 41 may be agitated to encourage the flow of material from the outlets 40 as necessary, depending upon the characteristics of the particular powdered or particulate material in any case. The streams of material from the outlets 40 again form thin dispersed layers flowing down each surface which are mixed, as before.

Means may be provided at the outlet(s) of one or both of the supply hoppers in all the above described embodiments by which the rate of flow of material from one or both of the hoppers may be controlled, to control the proportions of each material which are mixed. Thus, on-line control of mixing proportions may be achieved. For example, a sliding plate or variable size outlet aperture may be provided, under solenoid control, which may in turn be controlled via process control electronics or computing means.

Quantities of sand and salt have been mixed utilising apparatus generally as described and shown in Figure 1 with two flow surfaces each inclined at approximately 45° to the horizontal and to each other. Good mixing of the sand and salt was achieved to provide a relatively homogeneous mixture.

More than two materials can be mixed using the method of the invention. Apparatus similar to those described above may mix three or more granular material flows in sequential stages for example. Alternatively three or more layer flows could be directed onto a single flow surface for example.

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The foregoing described the invention including preferred forms, and alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated in the scope hereof as defined in the following claims.

CLAIMS

1. A method of mixing granular or powdered materials, comprising causing a stream of a first granular or powdered material to flow over an inclined surface as a thin dispersed layer flowing down said surface, causing a stream of a second granular or powdered material to flow over an inclined surface as a similar flowing thin dispersed layer flowing down said surface, and causing said layer flow of said second material to intersect with said layer flow of said first material to intimately mix said materials.

2. A method according to claim 1 including causing said layer flow of said second material to spill from an edge of said surface into said layer flow of said first material on said surface to intersect and intimately mix with said first material.

3. A method according to claim 2 including causing said layer flow of said first material to spill from a first edge and said layer flow of said second material to spill from a second edge into the flow of the first material beneath said first edge, whereby said materials intersect and intimately mix.

4. A method according to claim 2 including causing said streams of said first and second materials to flow over and spread to a thin dispersed layer each on the same surface, and to intimately mix by intersection of said layer flows on said surface.

5. A method according to anyone of claims 1 to 4 including causing said streams of the first and second materials to fall under gravity to impact the surface(s) and flow over the surface(s) spreading from their points of impact to said thin dispersed layers.

6. Apparatus for mixing granular or powdered materials, comprising a first inclined surface, means to direct a first granular or powdered material onto the first surface to spread to a thin dispersed layer flowing down the surface, a second surface inclined to the horizontal and towards said first surface, and means to direct a second granular or powdered material onto the second surface to spread to a similar flowing thin dispersed layer, whereby said layer flow of said first material spills from an edge of said second surface to intersect and intimately mix with said first material.

7. Apparatus for mixing granular or powdered material, comprising an inclined surface, means to direct a first granular or powdered material onto the surface to

spread to a thin dispersed layer flowing down the surface, means to direct a second granular or powdered material onto the surface to spread to a thin dispersed layer flowing down the surface whereby said materials intimately mix on the surface.

8. Apparatus according to either one of claims 6 and 7 wherein the streams of material are arranged to fall under gravity to impact the surface(s) and flow over the surface(s) spreading to said thin dispersed layers.

9. Apparatus according to claim 8 wherein the apparatus comprises flow guides at the sides of one or both of the flows or immediately above the point of impact of each stream of material onto the surface(s) to direct the material flow.

10. Apparatus according to claim 9 comprising two flow guides positioned immediately above the point of impact of one or each of the streams of material flow onto the surface with one of said guides to each side at the point(s) of impact.

11. A method of mixing granular or powdered materials, substantially as herein described with reference to any one or more of the accompanying drawings.

12. Apparatus for mixing granular or powdered materials, substantially as herein described with reference to any one or more of the accompanying drawings.

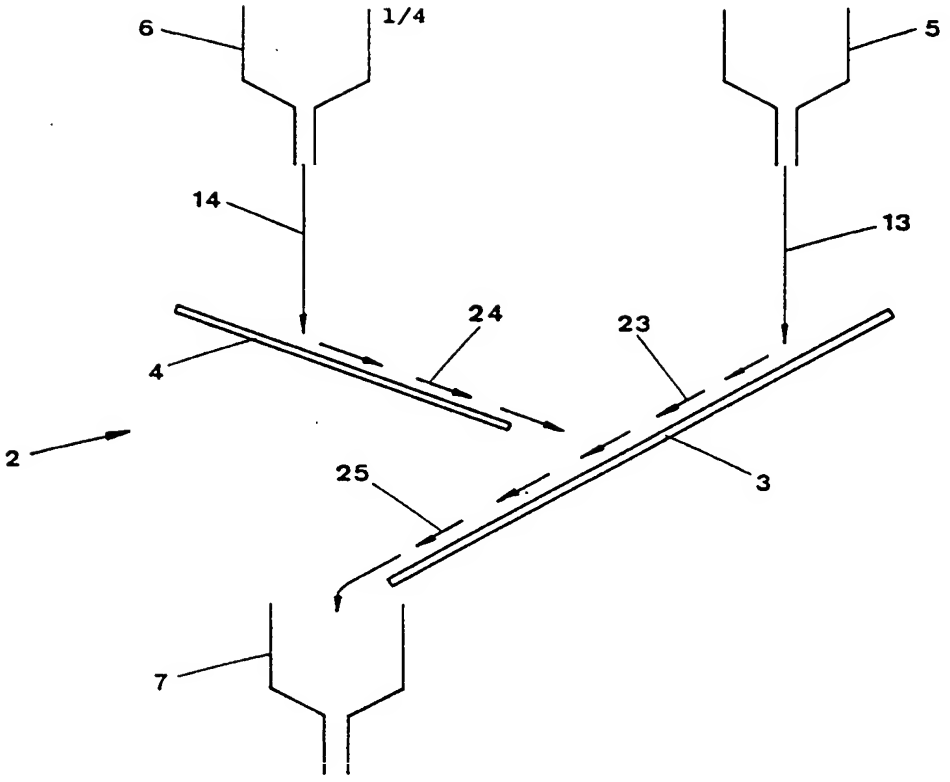

Figure 1

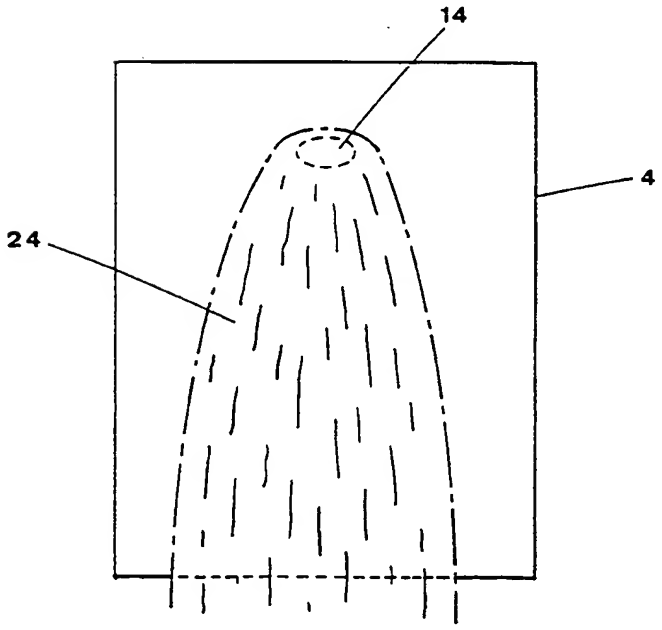

Figure 2

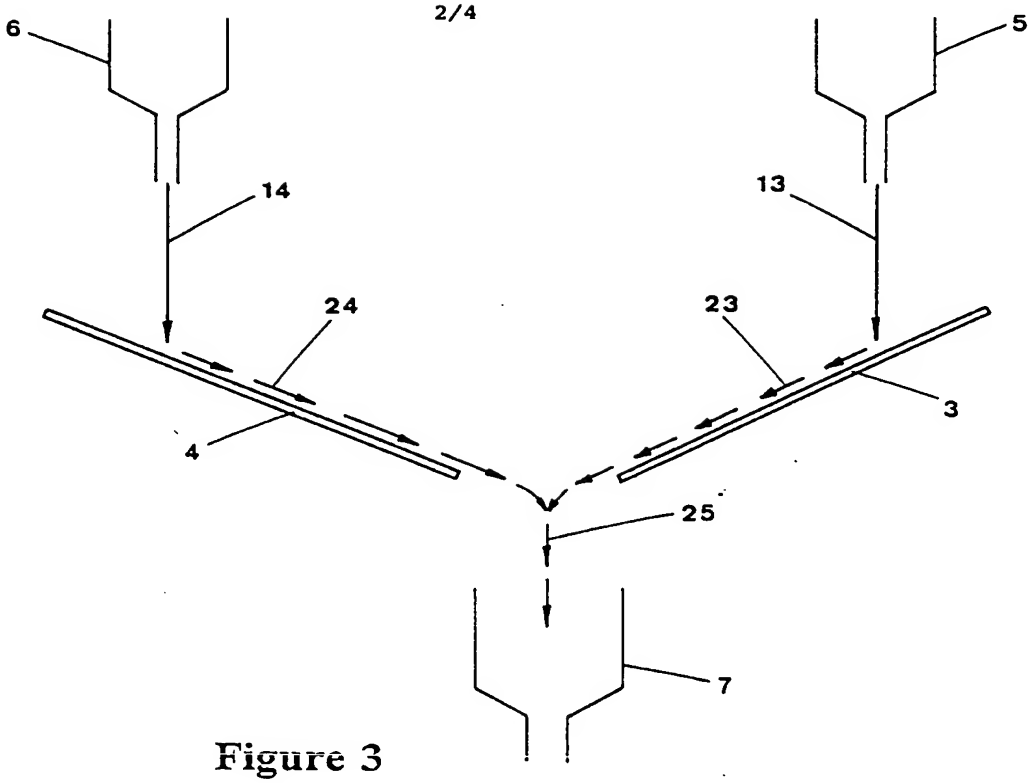

Figure 3

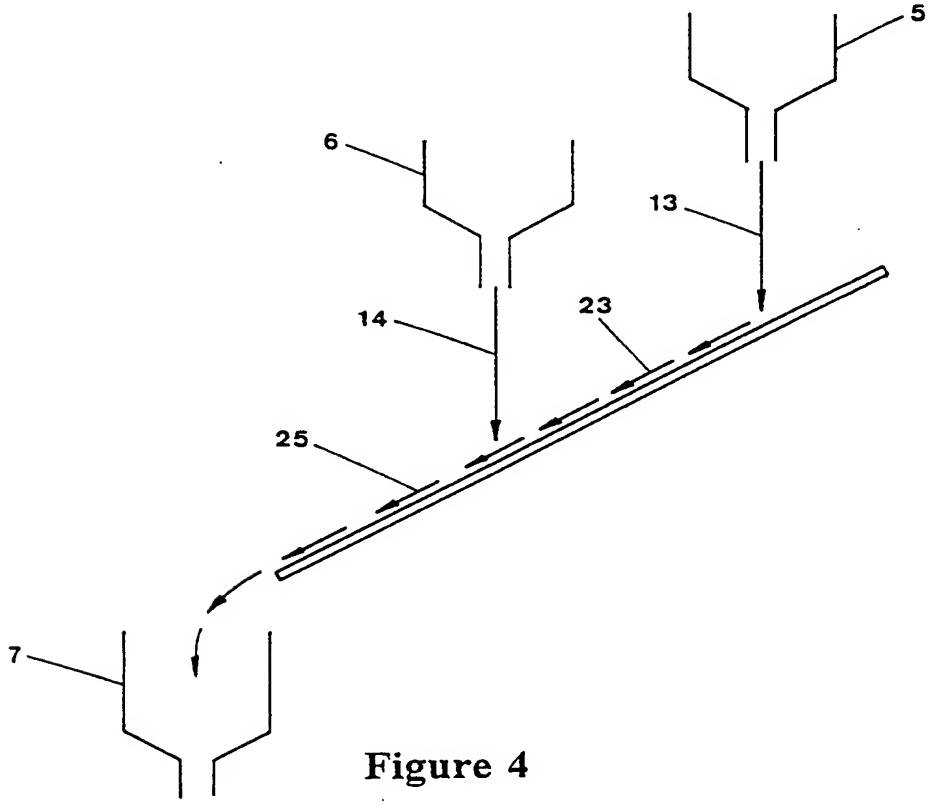

Figure 4

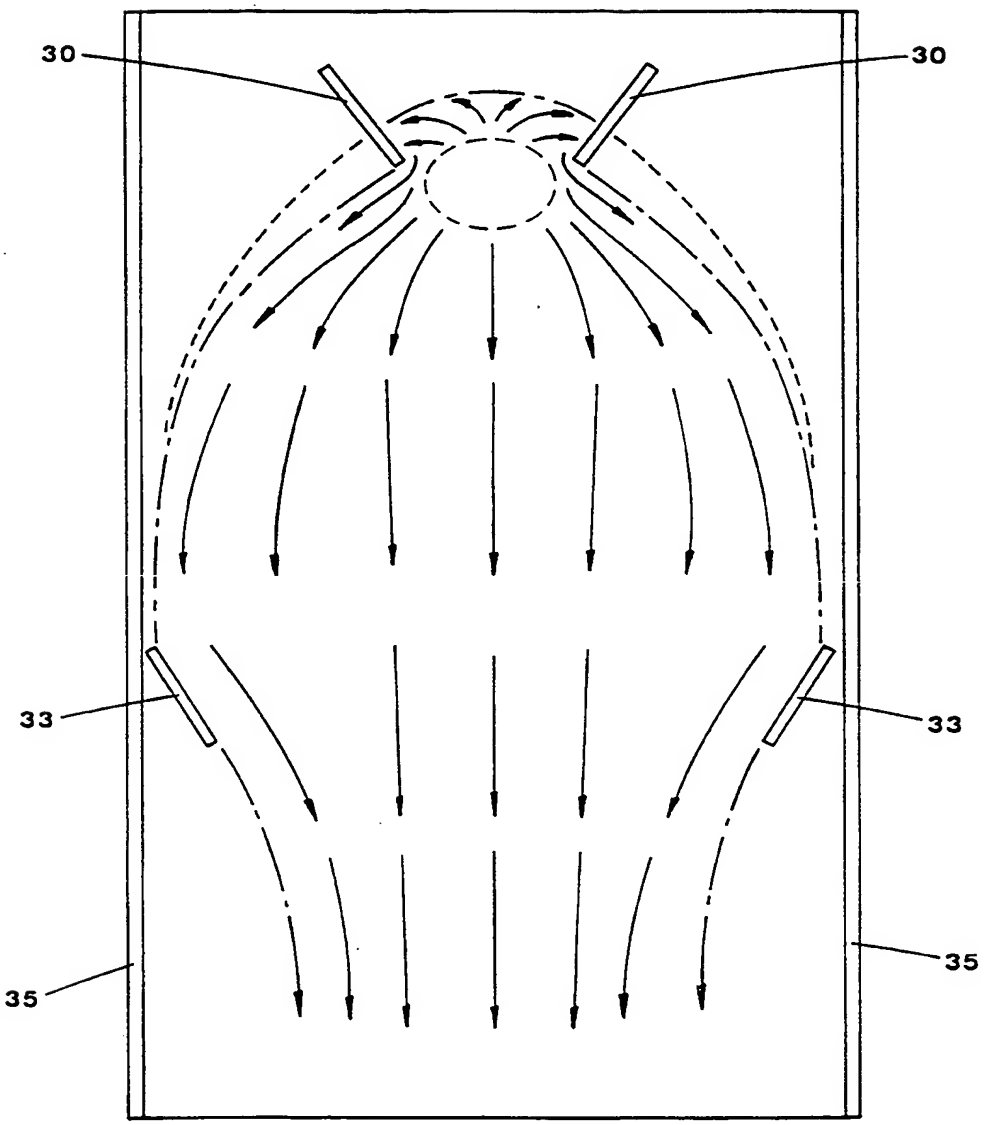

Figure 5

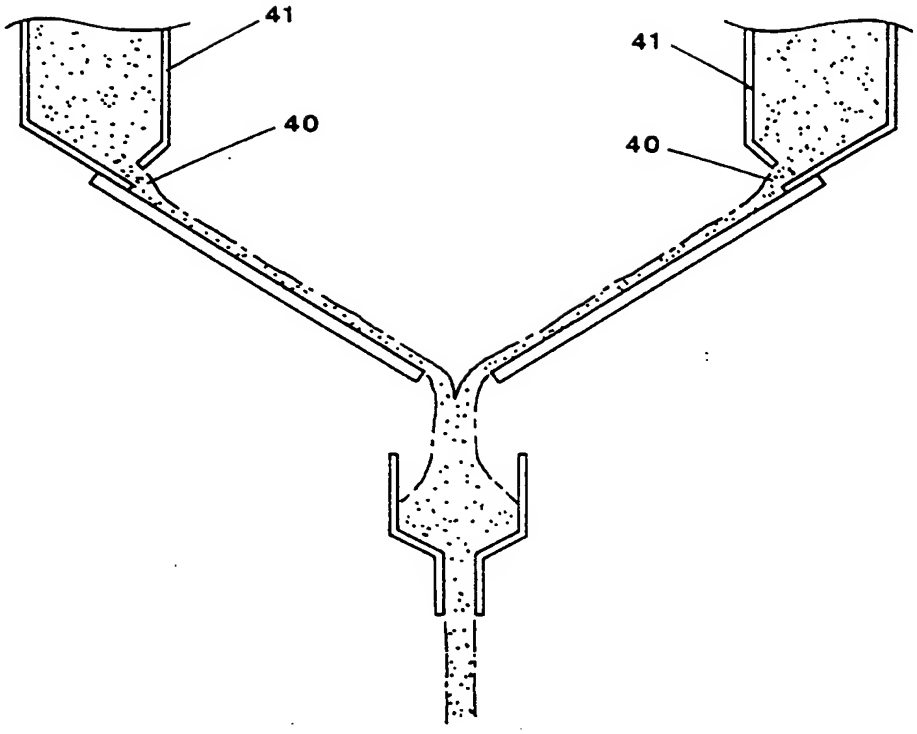

Figure 6

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/NZ 98/00014

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B01F 5/24, B01F 3/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC6: B01F 5/24, 3/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5 064 099 (IWAKO) 12 November 1991 See whole document	1-12
X	FR, A, 2 300 610 (FONDERIES ET CONSTRUCTIONS DE SAINT-OMER) 10 September 1996 See whole document	1-12
A	EP, A, 89612 (PHILLIPS PETROLEUM COMPANY) 28 September 1983	
A	AU, A, 30912/84 (554567) (PHILLIPS PETROLEUM COMPANY) 28 February 1985	
A	WO, A, 92/18229 (AVERY) 29 October 1992	

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent Document Cited in Search Report		Patent Family Member					
US	5064099	AU	49268/90	CA	2009495	CN	1044797
		DE	4004005	GB	2229105	JP	2209324
EP	89612	AU	11993/83	CA	1183522	ES	520639
		ES	8402730	JP	58170528	US	4472064
AU	30912/84	CA	1207749	EP	139167	ES	535426
		ES	8606007	JP	60061026	US	4518260
		US	4553849				
WO	9218229	AU	18875/92	CA	2087178	EP	538445
		US	5123749	US	5411332		

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